Circular Motion 3

1) a)

$\Sigma F = T + F_g$ (down is +)

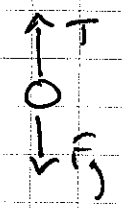
$\frac{mv^2}{r} = T + mg$

$T = \frac{mv^2}{r} - mg$

$= \frac{(0.335)(3.25)^2}{(0.85)} - (0.335)(9.8)$

$T = \boxed{0.88\ N}$

b)



$\Sigma F = T - F_g$ (up is +)

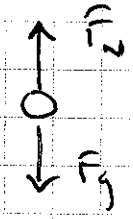
$\frac{mv^2}{r} = T - mg$

$T = \frac{mv^2}{r} + mg$

$= \frac{(0.335)(3.25)^2}{(0.85)} + (0.335)(9.8)$

$T = \boxed{7.45\ N}$

②



when weightless, $F_N = 0$

$\therefore \Sigma F = F_g$

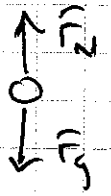
$$\frac{mv^2}{r} = mg$$

$$\frac{v^2}{r} = g$$

$$\frac{15^2}{r} = 9.8$$

$$r = \frac{15^2}{9.8} = \boxed{4716.8 \text{ m}}$$

③



$F_g = mg$

$F_N = 3F_g = 3mg$

$\Sigma F = F_N - F_g$

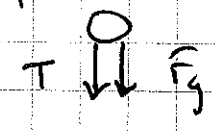
$$\frac{mv^2}{r} = 3mg - mg$$

$$\frac{mv^2}{r} = 2mg$$

$$r = \frac{v^2}{2g}$$

$$r = \frac{230^2}{2(9.8)} = \boxed{2699 \text{ m}}$$

④ a)



$\Sigma F = T + F_g$ (down is +)

$\frac{mv^2}{r} = T + mg$

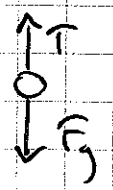
$\frac{0.25 v^2}{0.5} = 14 + (0.25)(9.8)$

$0.5 v^2 = 16.45$

$v^2 = 32.9$

$v = \boxed{5.74 \text{ m/s}}$

b)



$\Sigma F = T - F_g$ (up is +)

$\frac{mv^2}{r} = T - mg$

$\frac{0.25 v^2}{0.5} = 14 - (0.25)(9.8)$

$0.5 v^2 = 11.55$

$v^2 = 23.1$

$v = \boxed{4.81 \text{ m/s}}$

⑤

$$\Sigma F = T - F_g$$

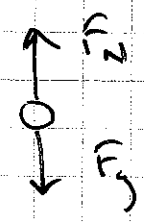
$$\frac{mv^2}{r} = T - mg$$

$$\frac{(2100)(7.6)^2}{15} = T - (2100)(9.8)$$

$$8086.4 = T - 20580$$

$$T = \boxed{28\,666.4 \text{ N}}$$

⑥



when the car leaves the ground,

$F_N = 0$

so $\Sigma F = F_g$

$$\frac{mv^2}{r} = mg$$

$$v^2 = rg$$

$$v = \sqrt{(165)(9.8)}$$

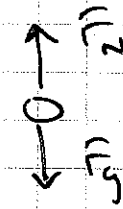
$$v = \boxed{40.2 \text{ m/s}}$$

(7) Note: $1\ g = 9.8\ m/s^2$

a) $v = 220\ km/h = 61.\overline{1}\ m/s$

$$a = \frac{v^2}{r} = \frac{(61.\overline{1})^2}{180} = 20.748\ m/s^2$$

$$\frac{20.748}{9.8} = \boxed{2.12}\ g's$$

b) 

F_N = apparent weight

$\Sigma \vec{F} = \vec{F}_N - \vec{F}_g$

$ma = F_N - mg$

$F_N = ma + mg$

$= m(2.12g) + mg$

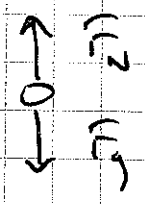
$F_N = 3.12\ mg$

The pilot appears to weigh $\boxed{3.12}$ times his normal weight (mg).

⑧ $v = 180 \text{ km/h} = 50 \text{ m/s}$

Since the scale reads 4 times normal,

$F_N = 4F_g$



$$\Sigma F = F_N - F_g$$

$$\frac{mv^2}{r} = 4F_g - F_g$$

$$= 3F_g$$

$$\frac{mv^2}{r} = 3mg$$

$$r = \frac{v^2}{3g}$$

$$= \frac{50^2}{3(9.8)}$$

$$r = \boxed{85.0 \text{ m}}$$